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TECTONIC STRUCTURE OF ALASKA AS EVIDENCED BY ERTS IMAGERY AND ONGOING SEISMICITY

Progress Report
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Problems

None.

Accomplishments

During the past reporting period, a great deal of imagery was received of areas not covered in previous reports. Notable among these is that part of northern Alaska traversed by the Brooks Range. These mountains are dissected by multitudinous strong lineaments, some of which are known to be major thrust faults. Concurrently with this study, we are attempting to instrument the Brooks Range with seismic gear, and this will provide the opportunity to compare the locations of epicenters with lineaments visible on the imagery, as we have been doing in other parts of the state. At present, four stations have been nearly completed, and it is hoped that nine will be in operation by the end of the year. The instrumentation program is being supported by the U. S. Geological Survey.

We were recently engaged by the U. S. Army Corps of Engineers, Alaska Division, to perform a lineament and seismicity study of the Talkeetna Mountains area. This is the proposed site for two dams on the Susitna River, one at Devil Canyon and one at Watana. The object of the report, a portion of which appears in the following section on Significant Results, was to assess geologic hazards. This project was carried out on a cost-sharing basis with the Corps of Engineers, an effort co-funded by them in the approximate amount of $7,000 (final figures are not yet available).

Arrangements have been made to carry out, in the months ahead, a joint study with Dr. V. I. Keylis-Borok of the Institute of Physics of

the Earth, Academy of Sciences of the U.S.S.R. We will be collaborating on the tectonic structure of Alaska evidenced by LANDSAT imagery and earthquakes.

Significant Results

This report is a portion of a study done for the U. S. Army Corps of Engineers, and is an attempt to evaluate geologic hazards in an area where the construction of two major hydroelectric facilities is being planned. It considers tectonic lineaments in that portion of south-central Alaska bounded by latitudes 61°-63° 45'N and longitudes 146°-153°W. The area is centered on the Talkeetna Mountains, and includes Mt. McKinley to the north and the northern portion of Cook Inlet to the south.

Both geologically and tectonically, this is a complex area. It overlies the region where the north Pacific lithospheric plate is being thrust under the North American Plate from the southeast. Because of this it is seismically active, and the complicated geologic relationships and tectonic processes affecting the area are only partially understood.

In the preparation of this report, we consider (i) lineaments which are discernable on satellite (LANDSAT) imagery which we feel to be of tectonic origin, and (ii) smaller lineaments in the central part of the region (Susitna River area) employing imagery obtained from side-looking airborne radar (SLAR).

In selecting linears from the imagery, it is difficult to know where to "draw the line". Any number of linear features can be traced, depending on the selection criteria. We have attempted to include only

those which we feel to have a definite tectonic origin, based on length, sharpness, and on such factors as whether or not they cross drainage divides. Realizing that some of those which we pick are more than likely erosional features arising from structural elements other than faults (such as folds or pluton boundaries), a fracture origin (and subsequent erosion) is assumed for most of them.

A mosaic of the study area was constructed from selected portions of eleven LANDSAT images at a scale of 1:1,000,000. Band 7 images were utilized because of their superior haze-cutting characteristics.

On the basis of the LANDSAT imagery, the area is clearly dominated by two principal features. These are the Denali and Castle Mountain-Fairweather fault systems which traverse the mosaic from east to west near the northern and southern margins. These faults have been fully documented in the field and are known to be large scale right-lateral faults, although evidence of recent offset is lacking. Probably the next most remarkable feature is the apparent graben formed by the western flanks of the Talkeetna and Chugach Ranges, and the eastern flank of the Alaska Range.

In the interests of the present study, the most significant aspect to the mosaic is a dominant NE-SW striking structural grain of the Talkeetna Mountains-Alaska Range complex. It is apparent that several strong lineaments intersect the Denali fault from the southwest. The most striking of these follows the southeast margin of the Alaska Range and intersects the Denali fault near Windy. A second lineament parallels this some 60 km to the east and intersects the Denali fault in the depression occupied by the Susitna glacier. This lineament, which we

originally noticed on the LANDSAT (at that time, ERTS) imagery and temporarily dubbed the "Susitna fault" has since been confirmed in the field as being a genuine fault on the basis of rock differentiation, age dating, and seismicity. This, and other sub-parallel lineaments in the area establish the dominant structural trend. A secondary set of fractures strikes across the entire area in a NNW-SSE direction. The principal one of these is the valley of the upper Talkeetna River. The Sheep River valley is another, and we regard many lineaments parallel to these two principal directions of tectonic trend to be elements of the same fracture system, and thus subject to essentially the same level of seismicity.

While satellite imagery is useful in obtaining a knowledge of general tectonic grains, the resolution which it provides is insufficient to permit the assessment of structural relationships on a local scale. To this end, side-looking radar imagery of the Susitna River area was provided to the investigators by the Corps of Engineers.

In contrast to the treatment accorded the LANDSAT imagery, the longest lineaments apparent on the SLAR imagery were ignored, and emphasis was placed instead on treating the lesser structural elements within the province. Specifically, only those lineaments less than 15 miles (25 km) in length were catalogued. In a statistical analysis, it is hoped that this procedure will negate the overriding influence on the calculations of the dominant structural features and provide an insight into the mode of deformation occurring in the surrounding areas.

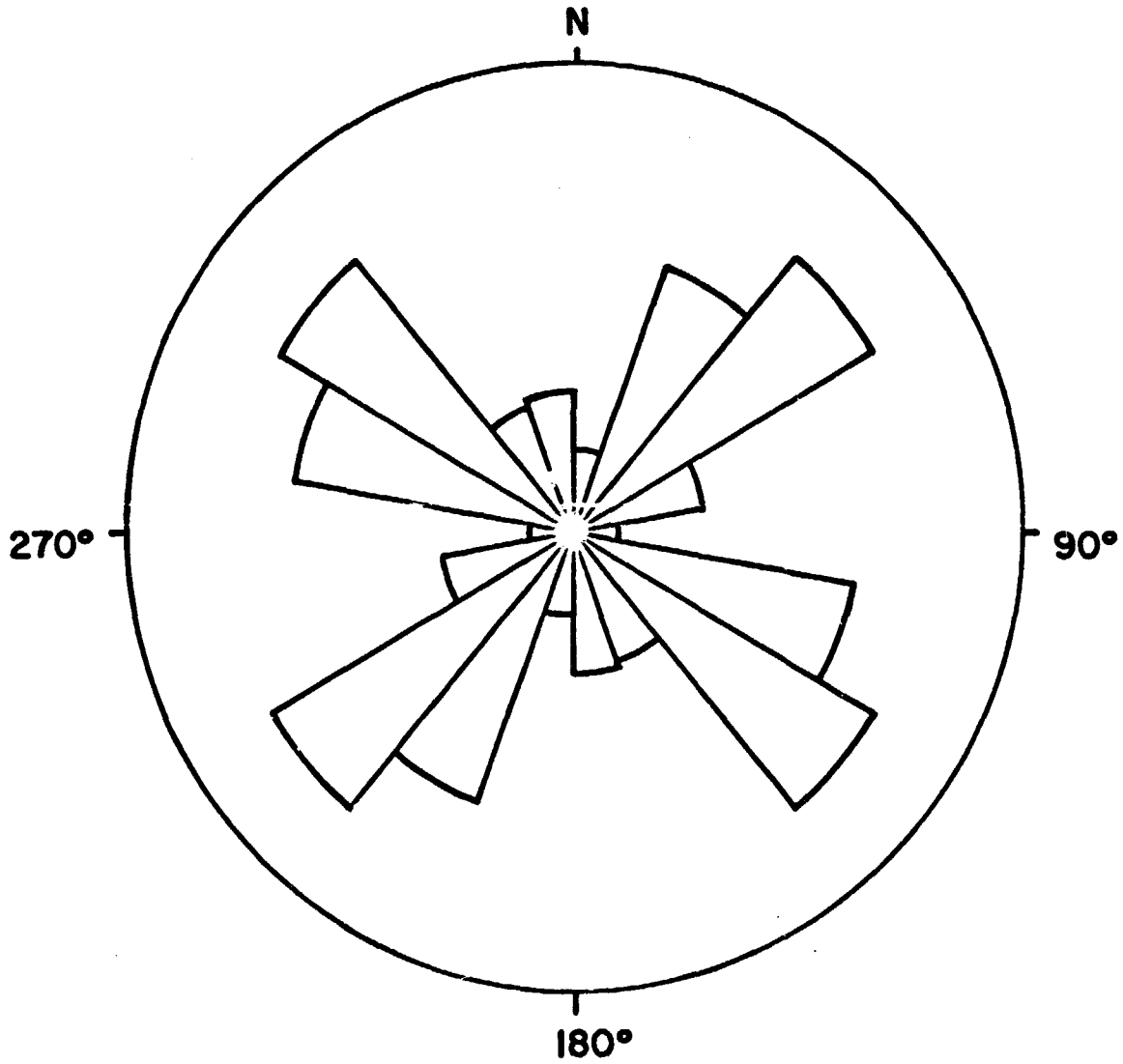
Table I and the following rose diagrams sum up the information which was obtained from plotting a total of 368 lesser lineaments from

TABLE I

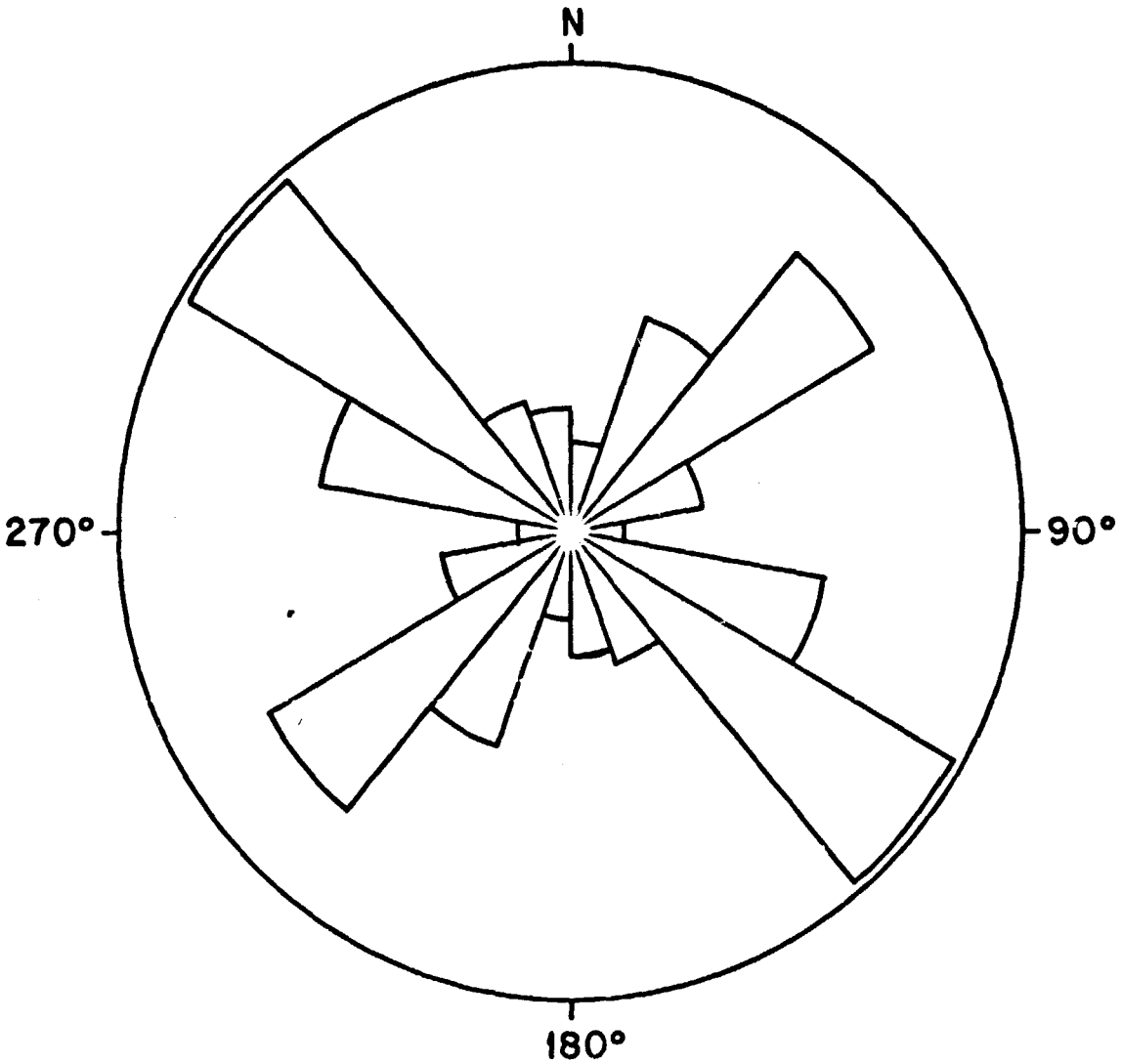
Tabulation of lesser lineaments seen on SLAR Imagery. Lineaments longer than 15 Miles (25 km) were omitted so that the Susitna Fault and other long, sub-parallel lineaments are not represented.

Azimuth	Number of Lineaments	Additive Length of Lineaments		Average Length of Lineaments		% Total Number of Lineaments	% Total Length of Lineaments
		mi	km	mi	km		
0-20	18	45.1	72.7	2.5	4.0	4.9	4.5
20-40	45	154.9	248.1	3.4	5.5	12.2	15.3
40-60	72	197.0	317.6	2.7	4.4	19.5	19.5
60-80	27	76.0	122.4	2.8	4.5	7.4	7.5
80-100	11	27.4	44.2	2.5	4.0	3.0	2.7
100-120	52	161.2	259.9	3.1	5.0	14.1	16.0
120-140	90	194.5	313.6	2.2	3.5	24.5	19.3
140-160	28	73.5	118.5	2.6	4.3	7.6	7.3
160-180	25	79.9	128.8	3.2	5.1	6.8	7.9

Total number of lineaments: 368
Total length of lineaments: 1010 mi = 1625 km



% TOTAL LENGTH
OF LINEAMENTS
outer circle represents 25% of
total of lengths measured.



% TOTAL NUMBER
OF LINEAMENTS
outer circle represents 25%
of total of lineaments picked.

the SLAR imagery. The picture which emerges is essentially the same as that obtained from the satellite imagery: principal lineament orientations to the NE and NW, with greatly lesser numbers occurring at intermediate azimuths.

Further evaluation of the imagery, the table and the figures reveals the significant fact that those lineaments striking NE (roughly paralleling the Susitna fault), while fewer in number than those striking to the NW, are generally longer and stronger than those striking to the NW. The latter tend, in many cases, to be short and abruptly truncated.

The supposition that the Susitna fault represents the primary azimuth of (lateral) offset in the area is therefore strengthened, and it is seen that a strong set of shorter, secondary faults strikes nearly at right angles to this.

It is interesting that the occurrence of lineaments in an E-W direction is practically nil, and that this makes it seem unlikely that the course of the Susitna River, which runs nearly E-W, is fault-controlled.

Publications

Gedney, Larry and James VanWormer, Tectonic lineaments and plate tectonics in south-central Alaska, First International Symposium on the New Basement Tectonics, University of Utah Press, 1975.

Gedney, Larry and Lewis Shapiro, Structural lineaments, seismicity and geology of the Talkeetna Mountains area, Alaska, prepared for the U. S. Army Corps of Engineers, Alaska Division, Anchorage, Alaska, September 1975.

Recommendations

None.

Funds Expended

$32,000.

Data Use

Value of Data Allowed	Value of Data Ordered	Value of Data Received
$7,300	$7,300	$1,430

Aircraft Data

While no NASA aircraft data were supplied, the Corps of Engineers provided some SLAR data of the Talkeetna Mountains area. These are discussed in the section on Significant Results.